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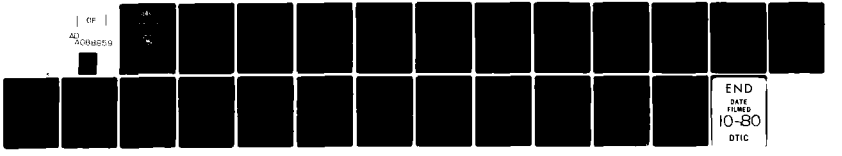

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COLOR UNIFORMITY IN NAVY UNIFORMS

NAVY CLOTHING AND TEXTILE RESEARCH FACILITY

NATICK, MASSACHUSETTS

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The lack of color uniformity and appearance in Navy dress clothing is not only related to the shade evaluation of fabrics being procured, or the proposed "tightening" of shade tolerances, but also stems from a variety of factors including: shade variations in horizontal and vertical matches; the effect wear and/or cleaning; appearance under different lighting conditions; fiber composition of fabrics and dyeing methods; contractor furnished material versus government furnished material; fabric source,

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20. ABSTRACT (continued).

e.g., standard stock Navy Exchange and commercial outlets; availability of dye and government restrictions, and continual change in Navy uniforms dictated by uniform decisionmakers. Considering all the variables listed above, shade variations are controlled as well as possible by the current methodology. To lessen the degree of variation would entail such unpopular steps as returning to dry cleaned garments only, eliminating optional fabrics, enforcing the disposal of garments after a prescribed number of cleanings, and legislating laundering methods and soaps. (U)

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COLOR UNIFORMITY IN NAVY UNIFORMS

INTRODUCTION

The problem of the lack of color uniformity in standard Navy uniform fabrics and in the value of developing color standards and shade tolerances for the fabrics used in dress clothing is not new. It has been a matter of concern to the Navy as well as the other branches of the Armed Forces for many years. References 1 through 4 are papers presented by DOD personnel regarding various aspects of shade difficulties. However, the problem has become more visible during the past few years because of the increased usage of blended (natural/synthetic combinations) and 100% synthetic fabrics in clothing and textile items. In response to a request from the Chief of Naval Personnel to the Naval Supply Systems Command, the Navy Clothing & Textile Research Facility (NCTRF) has prepared this report to identify problem areas in attaining color uniformity and to include information concerning the effort to achieve an acceptable degree of color uniformity in uniforms for the men and women in the Navy (5 & 6).

PRESENT SYSTEM FOR THE CONTROL OF COLOR IN FABRICS

The Navy uses standard shade samples representing various colors and types of materials required in the manufacture of the various dress and utility uniform items required for Navy men and women. These standard color shade samples were individually dyed as a new color, or a new fabric was adopted by the Navy during NCTRF's material development work. In some instances, a standard was selected from the initial procurement of the new material by the Defense Personnel Support Center (DPSC) using the same color standard of another fabric.

Yardage of each standard sample that NCTRF has established is forwarded to DPSC for issue to successful contractor bidders. The samples serve both as color standard visual guides for procurement purposes and as standards for colorfastness requirements and finishes specified in the applicable material specifications.

The Navy <u>does not</u> now have engineered shade tolerance ranges beyond which the shade or color would not be acceptable. In the absence of established shade tolerance samples under the present method, it is the co-responsibility of the procurement agency (DPSC) and the Technical Support Division of NCTRF (which makes the final decision if there are any disputes on shade) to establish an acceptable color tolerance range for a particular fabric as the dyed shade samples representative of the yardage being produced under contract are received for color evaluation. The sample swatches representing the tolerance range are then retained and used as a yardstick for subsequent procurements of the same fabric. All of the official tolerances established in this manner for the various fabrics are retained by the Shade Evaluation Branch at DPSC where they are used as required.

Based on the current procedure as described above, the standard color samples and the acceptable shade tolerances for these standards have reduced some of the variables on decisions concerned with shade acceptability. This method provides the procurement agency (which does all the shade evaluations for all services with the approval of the requesting service in questionable areas) and the commercial contractor with common and consistent visual means for both dyeing and evaluating required colors and limitations of shade acceptability, beyond which would be cause for rejection. However, it has been DPSC's procurement policy to provide the successful contractor only with a swatch of the standard shade sample. The contractor does not receive sample swatches of the developed tolerance shades. The shade tolerance samples are used by DPSC personnel to evaluate, for acceptance or rejection, samples submitted from the contractor's plant. In case of rejections or dispute regarding any shade samples submitted for evaluation, the contractor can visit DPSC and see the standard shade tolerance samples being used for shade evaluations.

In 1972, the Defense Personnel Support Center hosted a Joint Conference among personnel from DPSC and all of the military services' R&D activities on the subject of providing shade tolerances to industry. The conference was called because at the time DPSC was proposing to go much more extensively to Contractor Furnished Materials on clothing procurements (including dress items) as compared to providing Government Furnished Materials for such contracts. Mr. Frank Rizzo of the Natick Army Research and Development Command (NARADCOM), a recognized color expert, presented a paper on the subject (1). As noted in reference (1), the establishment of a foolproof system for issuing shade tolerances to industry would be very complex and expensive to institute. In addition, the control required to insure that the samples provided to contractors would be maintained and used properly is also envisioned as being very difficult to manage and would lead to more contractual problems than would be solved. Since 1973, there has been little discussion between DPSC and the military services on this subject and there is no effort being made in this direction at this time.

The Army is the only service which over the years has developed and provided DPSC with standard engineered shade samples and shade tolerances for most of its dress uniform fabrics. Engineered in this context means developed under laboratory conditions and submitted to the procurement agency prior to initial procurement. This method contrasts with the other services' method of developing tolerances by actual experience during subsequent procurements. However, the Army still experiences color problems from time to time as determined during a recent discussion with shade evaluation personnel at DPSC. DPSC has assured this Facility that the non-availability of engineered shade tolerances on Navy fabrics is not a serious problem, nor would contractual problems relating to shade acceptability disappear if we developed new engineered standards with the necessary shade tolerances. The Navy has not developed engineered shade tolerance ranges for standard samples because of the expense and questionable value of this developmental effort. Sufficient funds are not allocated

to experimentally develop a dye formulation and dye material that will achieve the desired color. A known dye formulation is a necessary prerequisite for the development of an acceptable shade tolerance range. An acceptable shade tolerance range is achieved by making subtle dye percentage changes in the known formulation, experimentally dyeing the material using the new formulations, and establishing the limitations of acceptance of the dyed material. Except for one or two dress fabric shades, neither the Air Force, the Coast Guard nor the Marine Corps have engineered shade tolerance samples. However, the other services presently follow the same procedure described above for the Navy to establish their shade tolerance range for the various fabrics used in their uniforms.

Fabric manufacturers as a group believe that the present shade tolerance ranges of the military are too restrictive as witnessed by the high degree of rejection rate. This opinion has developed recently with the advent of increasing variety of materials introduced into the clothing system. They also contend that the acceptable tolerance ranges do not reflect present conditions of standard commercial acceptance levels or present commercial capabilities in the dyeing field. To further "tighten up" specifications by narrowing currently acceptable shade ranges will only result in fewer and higher bids, or no bidders because of the increased chance of rejection. Such a development would have a negative impact on the military posture in clothing and textiles. If DPSC were forced to procure substitute fabrics because of high rejection rates, the effect would only serve to exacerbate the already complex problem of shade uniformity.

COST OF DEVELOPING STANDARDS AND TOLERANCES

Recent discussions with commercial dyers and government laboratories have determined that, depending upon the fabric, the cost of developing a standard shade sample and an acceptable tolerance range (requiring eight tolerances) extends from several thousand dollars to several tens of thousands of dollars for: each white fabric; each 100% synthetic fabric; each all-wool and polyester/wool blend fabric; and every other type of blend fabric, such as, polyester/cotton or polyester/rayon. Moreover, eight shade tolerance samples are required to produce the full variance of the color spectrum, i.e., red--thin and full, green--thin and full, blue--thin and full, depth--thin and full. There are but three tolerances for whites--yellow, red, and green. There are approximately 20 fabrics (whites, tans and navy blues) used in dress clothing items that require standard color samples and shade tolerance ranges. This number includes optional fabrics, men's and women's, approved for sale in Navy Exchanges; and standard stock fabrics, men's and women's, procured by DPSC. It would be necessary to develop a new standard sample for each fabric, as the formulation used to dye the current standards is in most cases, privy information of each manufacturer. The total estimated cost for developing new standard samples and tolerance ranges would be several hundred thousand dollars for outside contract work.

OTHER CAUSES OF SHADE VARIATIONS

Shade Variance: Horizontal Versus Vertical Match

There are other considerations which play a major role in shade uniformity. In the military, there are two matching considerations. They are "side to side" match of service personnel standing in a line, (horizontal) and top body cover with trousers or skirts of the individual wearer (vertical). Commercially, the vertical match problem is circumvented by cutting the matching coats and trousers from the same rolls of material obtained from a single supplier. This is not done in the military procurements because economies are realized in contracting with a specific trouser, skirt, shirt or blouse manufacturer. Uniform items are issued on the basis of size and not on a top-bottom color match. If a coat manufacturer's material is on the "red side" but within an acceptable shade tolerance, and the trouser manufacturer's material is on the "green side" of the acceptance tolerance, the differences in color become readily evident on military personnel whether in military formation or not.

Another point to remember is that one person may be wearing clothing made from 100% polyester knit material, another a 100% wool woven, another a 55/45% of polyester/wool medium weight, etc. The percentage of fiber blend levels and the type of construction have a decided effect on visual appearance. All of the fabrics mentioned above have been authorized and approved for use in Navy uniforms. Also, within different types of fabrics there are more varibles by different weights and weaves which will reflect light and color differently to the observer.

Further complicating the subject of color uniformity is that synthetic fibers, particularly in whites, are produced by a number of manufacturers each employing their own formulation and finishing methods, all of which affect clothing appearance, color and shade (7).

Effect of Wear and/or Cleaning

Trousers are generally worn more often than coats, thereby making them more susceptible to color or shade changes. This is particularly true if the trousers are cleaned more often. In an assembly of service personnel in dress clothing, those wearing newer uniforms will exhibit a different appearance than those wearing older uniforms which may have lost some of their original coloration. In the case of whites, the polyester fibers in polyester/cotton or polyester/rayon blends retain dirt, soil, and oils much more readily than the cotton or rayon component. Consequently, the uniforms may appear gray or yellow if laundering procedures are not carefully followed.

Most white fabrics, especially those fabricated from 100% synthetic or synthetic/natural blends, are bleached and also whitened by fluorescent optical brighteners. These whitening agents possess poor fastness to light and laundering, but can be renewed in subsequent laundering operations

by detergents containing fluorescent whitening agents. In addition, fibers and/or fabrics from different manufacturers are treated with fluorescent whitening agents that vary in chemical structure, percentage "add-on", etc. These variables affect the appearance of whiteness of fabrics, particularly blended fabrics that have been laundered. As an example, when a polyester/cotton fabric is laundered with a detergent containing a cotton whitening agent, the cotton has a greater affinity for the whitener than does the polyester. Therefore, a 65/35 polyester/cotton fabric and a 50/50 polyester/cotton fabric may be similar in appearance prior to laundering but will not be exactly the same after laundering.

Because 100% wool dress uniforms are dry cleaned, the effects of wearing and cleaning do not present as serious a problem in shade changing. Drycleaning normally causes less color degradation than washing.

Visual Appearance Under Different Lighting Conditions

Another element to consider when observing lack of color uniformity in dressed military personnel is the type of lighting under which the observation is made. Fabric specifications require that all dyed cloth be examined for color acceptance under artificial daylight and under incandescent lamplight at standard color temperatures. Many fabrics, particularly blends, may match under one or both of the above types of light sources, but vary significantly under fluorescent lights. Uniforms are obviously worn under all conditions of lighting (sunlight, incandescent and fluorescent). It is impossible to expect or demand that all shades match under all lighting conditions since the dyes and/or finishes used will not provide this characteristic. Even the viewer's color perception changes with age since denigration of the eye lens causes the older (usually above 40) viewer to perceive colors as having a reddish cast or appearance.

Fiber Composition of Fabrics and Dyeing Methods

With the advent of new synthetic fibers, fabrics of fiber blends offering ease of care and durability began to dominate the commercial market and 100% natural fiber fabrics became more difficult to obtain. For this reason, and because of the high cost of the natural fibers, the military replaced most standard fabrics constructed from 100% natural fibers with blends and with 100% synthetic fabrics. Appendix A lists the stock and optional uniform fabrics with their pertinent characteristics.

Blend fabrics, normally comprised of one natural and one synthetic fiber, introduce another dimension to the color problems in military fabrics. Synthetic fibers are different in chemical composition from the natural fibers, leading to different chemical and physical properties. These chemical differences between the two fibers necessitate the use of different dye classes and dye formulations. This further complicates shade colorations and shade matching, as dyestuffs of various classes exhibit a wide range in colorations and colorfastness properties. Because thousands of dyes are used in textiles, all dyes are grouped into one of 14 dye classes. Most dyes within each class usually possess similar (but by no means equal) fastness property characteristics and, in most cases, each class must be processed by

a certain technique at a certain temperature which may vary significantly from the dye class being used to dye the other fiber in the blend. Examples are: the vat dye class which dyes cellulosics (e.g. cotton); acid and chrome dye classes which dye protein (wool); and the dispersed dye class which dyes synthetics (polyester, nylon, etc.).

It is impossible for fabrics to match a single color/shade standard sample when they have different fiber percentage blends and different chemical compositions, are dyed by different dyeing methods, and are constructed differently. For example, Navy shade 3346 in a 100% texturized polyester uniform fabric will not match Navy shade 3346 in an all-wool uniform fabric. Likewise, Navy shade 3346 in an all-wool fabric will not match Navy shade 3346 in a polyester/cotton fabric. This disparity is also true of all white and khaki shades procured in a variety of fabric types for the Navy.

Except for a few all-wool fabrics, the standard stock and optional (NAVRESSO) dress item fabrics approved for Navy use consist mainly of blends and 100% synthetic materials of varying weights and percentages of composition. As this trend toward more allowed fabrics continues, the color differences will continue to increase as the shade differences are more readily discernible in the intermixing of uniform fabrics of service personnel in formation. Yet, it could be simplistic to minimize the effort of improvement made in textile technology for the purpose of minimizing shades in color.

Modern dyeing techniques also account for the lack of color uniformity found in uniforms. Fabrics constructed from 100% synthetics are generally dyed in "batches" of 400-1000 yards in dye jet machines. This method makes it difficult to reproduce the same shade from one batch to the next because of the varying conditions which may exist from one dye jet to the next, varying techniques from one operator to the next, dyeing cycle duplicity, fabric preparation, quality control, etc. The continuous piece dyeing of polyester/cotton or polyester/rayon blends also poses a serious problem, as yardage is processed at speeds up to 130 yards/minute, making it difficult to control shade variations. In this method, thousands of yards may be processed off-shade before an adjustment to the dye formulation can be made. Only when trying to match uniforms, such as in the military, is this a problem.

The two dyeing techniques which produce the best shade uniformity are "stock" dyeing, which is used for woolen fabrics, and "top" dyeing, which is used for worsted fabrics. In both methods, the fibers are dyed prior to being spun into yarns. Both methods are quite costly as compared with those previously described, although greater shade control is realized. A faulty dyeing can be corrected either by re-dyeing or by dyeing other stock or top in a slightly different shade which is then blended with the off-shade dyeing to produce the desired shade of stock used to spin yarns.

It should also be noted that there exist differences in color durability between fabrics dyed by the various methods described. Piece dyeing and jet dyeing are generally associated with washable type clothing, while stock and top dyeing are generally associated with dry cleanable clothing. In addition, piece-dyed and jet-dyed goods, particularly in dark shade (3346), contain larger amounts of surface (loose or excess) dye because of poor penetration of the dye into the fiber. Most of this excess dye is removed after a few launderings, giving the garments a somewhat flat or faded appearance when compared with the stock and top dyed goods with their inherently better dye penetration. Consequently, less dye is removed during dry cleaning leading to greater color and shade uniformity.

Method of Government Procurement: CFM Versus GFM

Materials used in the manufacture of clothing and textile end-items can be either government furnished material (GFM), meaning the government supplies the fabric to the contractor, or contractor furnished material (CFM). The method of source determination is vested with the procurement officer who must consider which method will better serve the customer. Variations in the shade of end items can be affected by the particular method employed to furnish the materials for end-item usage.

If the material is CFM, the problems of shade variation are more pronounced because it is the responsibility of the contractor to utilize materials that match the established standard shade sample. In the majority of cases involving CFM materials, the government does not perform shade evaluations until (a) end-items have been fabricated or (b) materials have been marked, cut and/or assembled for fabrication. This increases the chance that some of the items or materials may be off shade and must be replaced. This may result in a delay in the completion of the contract leading to "not in stock" (NIS) supply. Additionally, the logistics picture at a given moment may dictate that it be prudent to accept slightly off-shade garments that do not materially affect appearance and serviceability instead of experiencing an out of stock position or to cause unnecessary economic injury to a supplier.

The problem of shade vaiation in materials is lessened if materials are GFM, since the government has examined and accepted the dyed material for compliance with shade and specification requirements prior to contractor use.

Uniform Sources: Standard Stock, Navy Exchange System and Commercial Outlets

An important factor relating to color differences in dress uniform fabrics is that there are three sources of military dress items: the Appropriated Fund (standard stock system); the Non-Appropriated Fund Navy Exchange Systems; and varied world-wide commercial outlets. Exchanges offer a larger variety of fabrics (standard fabrics plus approved

alternatives) produced by a number of manufacturers who have received approval under the Certification Program of NCTRF. The addition of more fabrics, standard shade samples, and shade tolerance ranges increases the number of shade variations. The greater the number of approved fabrics, the greater are the problems in achieving uniformity of color. However, to curtail the number of fabrics allowed would be a simplistic and naive approach because of the many advantages that are attained by the wearer by being allowed to have different blends and weights in his wardrobe. The only control over unauthorized uniforms purchased through commercial outlets is the amount of effort exercised by Commanding Officers, Officers, Chiefs and Petty Officers at every ship and station. Experience has shown that those individuals in charge DO NOT enforce the Navy uniform regulations. In fact, the more senior Navymen are usually the first to procure unauthorized fabrics overseas as they can more easily afford to buy more expensive commercial uniforms than the junior Navymen.

Availability of Dyes Vis-a-Vis Government Regulation

It is increasingly difficult to obtain some of the dyestuffs used in formulations for Navy shades. There are several factors responsible for this problem. Because of the increasingly high dye cost, industry has turned to less expensive dyes at the sacrifice of colorfastness. This, in turn, is making it economically unfeasible for dyestuff manufacturers to continue producing and stocking dyestuffs used in Navy formulations which demand more stringent colorfastness. Another important reason for the lack of dyestuff production is the increasing number of government restrictions that ban the use of certain chemicals that have either been determined to be or are suspected of being toxic or carcinogenic. Federal and state environmental restrictions also cause dyestuff shortages. Dye manufacturers are now required to dispose of their waste products and effluents in a more controlled and expensive manner. Strict regulations being placed on the composition of effluents have greatly affected the use of dyes containing metals for wool and wool-blend fabrics. This Facility for some time has been aware of problems associated with future availability of certain dyes and toxic chemicals used in dyeing Navy shades. This situation will continue to adversely influence military shading.

NCTRF is closely monitoring the dyestuff and chemical industries to keep abreast of any dyes or chemicals which are being considered for termination of production. In addition, we are working with major dyestuff companies to develop new dye formulations that comply with government regulations. As an example, a contract was recently awarded by NCTRF to develop a new dye formulation for Shade Blue 3346 for use on wool melton (22-oz. overcoat fabric). This work is being performed because of the increased difficulty in obtaining some of the chrome dyestuffs used in the present formulation as previously stated. Commercial production of this class of dyestuffs will be discontinued within the next several years.

Recently, a meeting was held with NCTRF, NARADCOM, and industry personnel to discuss problems associated with dyestuff availability. The meeting concluded that a vat blue dyestuff used in dye formulations for the Navy, Coast Guard, Air Force Military Academy, U.S. Military Academy and the Marine Corps was no longer available, necessitating that shades using this dye be reformulated. Additional information revealed that certain chrome dyestuffs used in Navy Blue 3346 will be phased out over the next 2 years for both environmental and economic reasons. Such action will affect the ability of fabric manufacturers to supply military fabrics meeting present specification color requirements. Furthermore, it is expected that premetallized dyes, substitutes being considered for chrome dyes, will also present an availability problem at some time in the future.

Conversion from vat blue and chrome dyestuffs to other classes of dyes on polyester/wool blends will present problems and require trade-offs in colorfastness leading to more shade variations to the viewer. R&D resources in the textile industry are almost entirely directed toward the solution of problems created by air, water, noise and chemical pollution regulations. There is every indication that the presently directed emphasis will continue into the forseeable future. Should this trend continue, it is entirely possible that in the future the military, including the Navy, will not be able to obtain clothing materials in the desired shades and colorfastness properties presently required. In all likelihood, a change in shade of standard samples would be necessary to utilize those dyestuffs that will remain available. When this happens, color and shading variations in military clothing will increase markedly.

Increased Interest in Commercial Commodity Acquisition Program (CCAP)

As an answer to the many logistics problems associated with the procurement and supply of military uniform items, the Department of Defense (DOD) and the Defense Logistics Agency Headquarters (DLAH) have approved and emphasized the increased use of commercially available items sold in the marketplace as a replacement for items procured under military specification requirements. To date, this effort has been directed toward items in which shade is not an immediate concern (e.g., handkerchiefs, towels, socks, etc.). However, it is logical to assume that the CCAP program will migrate into uniform items wherein shade differences will be perceived and a harangue will ensue. There are items such as wash khakis, utility jackets, work coveralls, and gloves that would be potential candidates for CCAP procurement if Navy management determines that shade proliferation is a lesser concern than economies, instant availability, and greater potential competition.

Mixing of Wash and Dry Clean Garments

There currently is a decided tendency in the Navy toward the use of 100% synthetic fabrics in clothing items, particularly in the new women's uniforms, because of their washability, resistance to wrinkling (no-iron) and lower cleaning costs. However, the use of a 100% synthetic fabric in the top coat portion of a dress uniform does not make the item washable. The other components parts (lining, interlining, facing, padding etc.) of that same coat cannot satisfactorily withstand laundering. Therefore, if the useful life of the item is to be maintained, the item should be drycleaned. Obviously, a dress uniform that permits the bottom portion or trousers to be laundered but necessitates that the top or coat portion be dry cleaned (as those items in shade 3346), will quickly lead to different shades between the top and bottom portions of the ensemble.

COLORIMETERS FOR SHADE EVALUATION

The military services and the Defense Personnel Support Center (DPSC) have minimized possible areas for controversy and disagreement over shade acceptability by having the final shade evaluation performed at one location under correct lighting and viewing conditions by trained personnel who specialize in shade matching. This is perfomed in the color laboratory at DPSC Philadelphia. Because this method does at times still produce controversy due to human perception, it has been suggested that tolerance ranges be established by assigning each tolerance a specifically engineered colorimetric numerical constant and that all shade evaluations be perfomed by colorimeters. Such an approach has many shortcomings which must be resolved before being considered a viable alternative method.

While color measuring instruments have improved significantly over the past decade, the data obtained with them have failed to reach the point of being akin to visual experience. For example, a colorimeter can evaluate the sample under only one form of light source. While the sample may be an acceptable match to the colorimeter, there may be a wide disparity in shade between samples when viewed under various other types of light source. Other deficiencies of colorimeters include the problem of comparability of results from one machine manufacturer to another and, quite frequently, in test results from the same machine when the sample is re-evaluated at a later date. Cost is still another important factor as the equipment is quite expensive. Also, calibration of these machines is very precise, delicate, and difficult, i.e., the slightest degree of calibration difficulties between a contractor's colorimeter and the government's colorimeter would cause rejection, confusion and litigation with its many adverse ramifications.

The Army Natick Research and Development Command (NARADCOM) has been funded by DOD to investigate the feasibility of adopting colorimeters for determining shade acceptance. They are currently evaluating various types of colorimeters to determine the most reliable. Once a specific colorimeter is selected, NARADCOM will then study the extent of variation in results between this machine and other types, the variation in results between similar models, and finally the degree of reproducibility of results within the machine itself. This study will not be completed until 1982.

CONCLUSIONS AND RECOMMENDATIONS

There are no simple and effective solutions, agreeable to all those concerned, that will answer the questions raised in respect to the lack of color uniformity in Navy dress clothing. Two possible approaches toward reducing some problems are: (a) the reduction in the number of presently approved dress fabrics; and, (b) the establishment of acceptable, engineered, shade tolerance ranges (for selected fabrics) that would be satisfactory to the Navy and industry.

Reduction in Approved Dress Fabric

Because of the large number of standard and certified fabrics approved for dress clothing, consideration could be given to the reduction of this number if slight color variances in dress clothing are deemed a problem of major importance. A note of caution must be raised at this point. A reduction in allowed materials will negate the many specific advantages afforded to the wearer of clothing by improvements in the state-of-the-art in the clothing industry. When we are tasked to clothe the Navy world-wide, 12 months a year, and in many different work environments, we penalize the wearer by not offering a choice of materials. The service member should be allowed to procure the right weight, weave, and composition of fabric that best suit the demands of locale and occupation. In the opinion of NCTRF, this is more important than the attendant shade variations that will be evident with such variety.

Establishment of Engineered Shade Tolerances and Ranges

Considering the time and cost involved in developing engineered tolerance ranges, and that this method has not enjoyed any noteworthy success, NCTRF recommends that this approach not be pursued. The current method used by DPSC for accepting Navy shades (i.e., technically cognizant personnel selecting tolerances from yardage being produced under contract) is considered a more realistic approach. NCTRF recommends that this procedure continue at least until the Army's study on the feasibility of using a computerized color inspection system is completed in 1982.

APPENDIX A

DESCRIPTION OF UNIFORM FABRICS

(Stock and Optional)

Cloth, 100% Wool, Melton, 22 oz/lin yd

Fiber Content:	100% Wool
Color:	Blue 3346
Spec. No.:	MIL-C-16290
End Item:	Overcoat, Men's
Method Issue:	Stock Item - DPSC Procured
Method of Dyeing:	Stock
Method of Cleaning:	Dry Cleaned

Cloth, 100% Wool, Serge, 12 oz/lin yd

Fiber Content:	100% Wool
Color:	Blue 3346
Spec. No.:	MIL-C-823
End Item:	Women's Overcoats and Hoods
Method of Issue:	Stock Item - DPSC Procured
Method of Dyeing:	Top
Method of Cleaning:	Dry Cleaned

Cloth, Serge, 100% Wool, 15 oz/lin yd

Fiber Content:	100% Wool
Color:	Blue 3346
Spec. No.:	MIL-C-823
End Item:	Uniform, Men's Service Dress and JNROTC
Method of Issue:	Stock Item - DPSC Procured
Method of Dyeing:	Top
Method of Cleaning:	Dry Cleaned

Cloth, Tropical, Polyester/Wool, 10 oz/lin yd

Fiber Content:	55/45, Polyester/Wool
Color:	Blue 3346
Spec. No.:	MIL-C-21115
End Item:	Uniforms, Men's Enlisted; NROTC and JNROTC
Method of Issue:	Stock Item - DPSC Procured
Method of Dyeing:	Top
Method of Cleaning:	Dry Cleaned

Cloth, Poplin, Polyester/Cotton, W.R., 6 oz/sq yd

Fiber Content:	50/50, Polyester/Cotton
Color:	Blue 3346
Spec. No.:	MIL-C-43482
End Item:	Raincoats, Men's and Women's, Women's Havelock
Method of Issue:	Stock Item - DPSC Procured
Method of Dyeing:	Standard Sample: Piece Dyed, Continuous Tolerance Range: Piece Dyed, Jig
Method of Cleaning:	Dry Cleaned

Cloth, Plain Weave, Polyester/Rayon, 6.5 oz/sq yd

Fiber Content:	65/35, Polyester/Rayon
Color:	Blue 3346
Spec. No.:	MIL-C-29147
End Item:	Men's Winter Shirt
Method of Issue:	Stock Item - DPSC Procured Optional - NAVRESSO
Method of Dyeing:	Standard Sample: Piece Dyed, Continuous Tolerance Range: Piece Dyed, Jig
Method of Cleaning:	Laundered

Cloth, Twill, Text, Polyester, 8 oz/sq yd

Fiber Content:	100% Texturized Polyester
Color:	Blue 3346
Spec. No.:	MIL-C-87050
End Item:	Women's Winter Uniform (new) Jacket, Skirt and Slacks
Method of Issue:	Stock Item - DPSC Procured
Method of Dyeing:	Piece Dyed, Jet
Method of Cleaning:	Laundered except for jacket which must be dry cleaned because of its construction and interlinings

Cloth, Twill, Text./Spun Polyester, 6 oz/sq yd

Fiber Content:	Warp: 100% Texturized Polyester Filling: 100% Spun Polyester
Color:	Blue 3346
Spec. No.:	MIL-C-87051
End Item:	Women's Winter Shirt (new)
Method of Issue:	Stock Item - DPSC Procured
Method of Dyeing:	Piece Dyed, Jet
Method of Cleaning:	Laundered

Cloth, Gabardine, Poly/Wool, 9.5 oz/lin yd

Fiber Content:	55/45, Polyester/Wool
Color:	Blue 3346
Spec. No.:	MIL-C-10176
End Item:	Officer's and Enlisted Men's Uniforms
Method of Issue:	Optional - NAVRESSO Procured
Method of Dyeing:	Top
Method of Cleaning:	Dry Cleaned

Cloth, Twill, Doubleknit, 6 oz/sq yd

Fiber Content:	100% Polyester
Color:	Blue 3346
Spec. No.:	MIL-C-29150
End Item:	Uniform, Men's, Service Dress Shirt and Trousers, Men's (work)
Method of Issue:	Optional - NAVRESSO
Method of Dyeing:	Piece Dyed, Jet
Method of Cleaning:	Laundered or Dry Cleaned

Cloth, Wool, Broadcloth, 22 oz/lin yd

Fiber Content:	100% Wool
Color:	Blue 3346
Spec. No.:	None
End Item:	Navy Academy Overcoat Officer's Bridgecoat
Method of Issue:	Procured by Naval Academy Optional - NAVRESSO
Method of Dyeing:	Top
Method of Cleaning:	Dry Cleaned

Cloth, Poplin, Poly/Cotton, 4 oz/sq yd

Fiber Content:	65/35 Polyester/Cotton
Color:	White 3013
Spec. No.:	MIL-C-21881
End Item:	Men's and Women's Short Sleeve Shirt-Insignia
Method of Issue:	Stock Item - DPSC Procured Optional - NAVRESSO Procured
Method of Dyeing:	Piece Dyed
Method of Cleaning:	Laundered

Cloth, Twill, Polyester/Cotton, 7 oz/sq yd

Fiber Content:	50/50 Polyester/Cotton
Color:	White 3053
Spec. No.:	MIL-C-29127
End Item:	EM Trousers and Food Handler's Clothing
Method of Issue:	Stock Item - DPSC Procured Optional - NAVRESSO Procured
Method of Dyeing:	Piece Dyed
Method of Cleaning:	Laundered

Cloth, Twill, Text. Polyester, 6 oz/sq yd

Fiber Content:	100% Texturized Polyester
Color:	White 3006
Spec. No.:	MIL-C-87052
End Item:	Women's Summer Skirt and Slacks (new)
Method of Issue:	Skirt: Stock Item - DPSC Procured Slacks: Optional - NAVRESSO
Method of Dyeing:	Piece Dyed, Jet
Method of Cleaning:	Laundered

Cloth, Twill, Polyester/Rayon, 8 oz/sq yd

Fiber Content:	65/35, Polyester/Rayon
Color:	White 3006
Spec. No.:	MIL-C-41820
End Item:	Officer's Dinner Dress Uniforms
Method of Issue:	Optional - NAVRESSO
Method of Dyeing:	Piece Dyed
Method of Cleaning:	Dry Cleaned

Cloth, Gabardine, Polyester/Wool, 9.5 oz/lin yd

Fiber Content:	55/45, Polyester/Wool
Color:	Tan 3729
Spec. No.:	MIL-C-10176
End Item:	Trousers, Men's
Method of Issue:	Optional - NAVRESSO Procured
Method of Dyeing:	Top
Method of Cleaning:	Dry Cleaned

Cloth, Tropical, Poly/Wool, 10 oz/lin yd

Fiber Content:	55/45, Polyester/Wool
Color:	Tan 3729
Spec. No.:	MIL-C-21115
End Item:	Trousers and Cap Covers, Men's
Method of Issue:	Optional - NAVRESSO Procured
Method of Dyeing:	Top
Method of Cleaning:	Dry Cleaned

Cloth, Twill, Text. Polyester, Double Knit, 6 oz/sq yd

Fiber Content:	100% Texturized Polyester
Color:	White 3006
Spec. No.:	MIL-C-29150
End Item:	Officer's Uniform Shirt and Trousers
Method of Issue:	Optional - NAVRESSO
Method of Dyeing:	Piece Dyed, Jet
Method of Cleaning:	Laundered or Dry Cleaned

Cloth, Twill, Double Knit, 6 oz/sq yd

Fiber Content:	100% Polyester
Color:	Tan 3729
Spec. No.:	MIL-C-29150
End Item:	Officer's Trousers, Shirts
Method of Issue:	Optional - NAVRESSO Procured
Method of Dyeing:	Piece Dyed, Jet
Method of Cleaning:	Laundered or Dry Cleaned

Appendix B - References

1. "Providing Shade Tolerances to Industry," Frank Rizzo, NARADCOM, Natick, MA, DPSC Joint Conference with Military R&D Activities, 9-10 March 1972.

2. "Color Uniformity in Khaki Summer Weight Suitings," T. J. Seary, R&T Div., NAVSUPSYSCOM, Washington, DC, prepared for the Navy Uniform Board, 21 June 1968.

3. "Foibles in Fabrics: Matching Colors in Uniforms - Catching a Chameleon" T.J. Seery, R&T Div, NAVSUPSYSCOM, Washington, DC, December 1970.

4. Variances in Shade Appearance of White Fabrics Used in Navy Uniforms, NCTRF, Materials Research Division, Natick, MA.

5. CHNAVPERS ltr Para-18-6A of 28 Jul 78.

6. NAVSUP ltr 0431F CEE of 7 Aug 78.

7. "Dyer Says Matching Problem Suddenly Turned Acute," Daily News Record, 18 September 1978, p. 20.